

Claims

1. A computer-implemented method of designing the geometrical size of a hydraulic element in a hydraulic system composed of hydraulic elements; the method having access to:
- a geometrical parameter representing geometrical size and shape of the hydraulic element and a flow resistance parameter representing flow resistance properties of the hydraulic element;
  - a numerical representation of simulated measures of the flow;
- wherein the numerical representation of the hydraulic system is open to changes in a calculated flow capacity through changes in a value of the flow resistance parameter;
- the method comprising the steps of:
- simulating measures of the flow at discrete instances of time and at discrete instances of space of the hydraulic system;
  - regulating a calculated value of the flow capacity in response to a design criterion by adjusting the flow resistance parameter to obtain a regulated value of the flow capacity; and
  - calculating the value of a geometrical size of the hydraulic element from the regulated value of the flow capacity and a specified flow resistance parameter.
2. A method according to claim 1, wherein the flow resistance parameter comprises roughness of the material of the hydraulic element.
3. A method according to claim 1 or 2, wherein the value of the geometrical size is calculated from the specified value of the flow resistance parameter, a value of the regulated value of the flow capacity, and specified geometrical shape and slope of the hydraulic element.

4. A method according to claim 3, wherein the hydraulic element is a pipe or channel and the value of the geometrical size (A;R) is calculated from the specified geometrical shape (A,R) of the pipe or channel, a specified roughness parameter (M), a specified geometrical slope (S) of the pipe or channel, and the regulated value of the flow capacity (Q) in accordance with the following equation:

$$Q = MAR^{\frac{2}{3}} \sqrt{S}$$

where:

- Q is the flow capacity,
- 10 M is Manning's number which represents the roughness of the material of the inside wall of the pipe or channel,
- A is the cross-sectional flow area of the pipe or channel,
- R is the hydraulic radius of the pipe or channel,
- S is the pipe slope of the pipe or channel;
- 15 the method having access to a procedure for determining the cross-sectional flow area and the hydraulic radius based on the size and shape of the pipe or channel.

5. A method according to claim 1, wherein a simulated measure of the flow is selected from the group of: level of a fluid in the hydraulic element and/or flow rate of the fluid in the hydraulic element and/or pressure in the hydraulic element.

6. A method according to claim 1, wherein the value of the flow resistance parameter is regulated during simulations by means of a simulated PID (Proportional, Integral and Differential) regulator strategy.

7. A method according to claim 1, wherein the value of the flow resistance parameter is regulated in response to the difference between a value of the selected simulated measure and the design criterion in the form of a predefined threshold value.

8. A method according to claim 1, wherein the step of regulating a calculated value of the flow capacity is performed over a finite period of time; and wherein the step of regulating the calculated value is reiterated with the regulated value of the geometrical size, if a design criterion is not fulfilled.
9. A method according to claim 1, wherein the step of simulating measures is performed over a series of finite length; and wherein the step of calculating a value of the geometrical size is performed when the step of simulating measures over the series of finite length has elapsed.
10. A method according to claim 1, wherein the hydraulic system is of at least one of the following groups:
- Wastewater systems
  - Storm drainage systems
  - Combined sewer systems
  - Wastewater treatment facility hydraulic systems.
  - Irrigation systems.
11. A method according to claim 1, wherein the numerical representation is a dynamic, one-dimensional model based on the solution of the Saint-Venant equations.
12. A computer-readable medium for making a computer execute the following method when run on a computer; the method having access to:
- a geometrical parameter representing geometrical size and shape of the hydraulic element and a flow resistance parameter representing flow resistance properties of the hydraulic element;
  - a numerical representation of simulated measures of the flow;

wherein the numerical representation of the hydraulic system is open to changes in a calculated flow capacity through changes in a value of the flow resistance parameter;

the method comprises the steps of:

5               simulating measures of the flow at discrete instances of time and at discrete instances of space of the hydraulic system;

                  regulating a value of the flow resistance to obtain a regulated value of the flow capacity; and

                  calculating the value of a geometrical size of the hydraulic  
10       element from the regulated value of the flow capacity and a specified flow resistance parameter.

13. A computer-implemented method of designing the geometrical size of a hydraulic element in a hydraulic system composed of hydraulic elements; the  
15       method having access to:

                  a geometrical parameter representing geometrical size and shape of the hydraulic element and a flow resistance parameter representing flow resistance properties of the hydraulic element;

                  a numerical representation of simulated measures of the flow;  
20       wherein the numerical representation of the hydraulic system is open to changes in a calculated flow capacity through changes in a value of the flow resistance parameter;

                  the method comprising the steps of:

                  simulating measures of the flow at discrete instances of time and  
25       at discrete instances of space of the hydraulic system; and

                  regulating a value of the flow resistance to obtain a regulated value of the flow capacity;

                  calculating the value of a geometrical size of the hydraulic  
                  element from the regulated value of the flow capacity and a specified flow  
30       resistance parameter.

14. A computer system for designing the geometrical size of a hydraulic element in a hydraulic system composed of hydraulic elements; the system comprising:

- 5 a data storage with a geometrical parameter representing geometrical size and shape of the hydraulic element and a flow resistance parameter representing flow resistance properties of the hydraulic element, and a numerical representation of simulated measures of the flow; wherein the numerical representation of the hydraulic system is open to changes in a calculated flow capacity through changes in a value of the flow resistance
- 10 parameter;
- simulator arranged to simulate measures of the flow at discrete instances of time and at discrete instances of space of the hydraulic system, a regulator arranged to regulate a value of the flow resistance to obtain a
- 15 regulated value of the flow capacity, and a converter arranged to calculate a value of a geometrical size of the hydraulic element from the regulated value of the flow capacity and a specified flow resistance parameter.